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METHOD AND DEVICE FOR LAMINATING OPTICAL DISK
[Hikari disuku hariawase hoho oyobi sochi]

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[CLAIMS] /*

[Claim 1] A method for laminating optical disk using a liquid ultraviolet-curing adhesive to laminate two single plate disks to form a single laminated disk, characterized by providing

a first ultraviolet irradiation process for obtaining uncured layered disks by irradiating ultraviolet rays to a degree not completely curing said ultraviolet-curing adhesive while mechanically aligning the center holes of the two single plate disks layered with the liquid ultraviolet-curing adhesive in between, and

a second ultraviolet irradiation process for irradiating said layered two single plate disks with ultraviolet rays to a degree completely curing said ultraviolet-curing adhesive to obtain a laminated disk.

[Claim 2] A method for laminating optical disk according to Claim 1, wherein

said first ultraviolet irradiation process is characterized by making said ultraviolet-curing adhesive between said two layered single plate disks a liquid to gel with increased viscosity.

[Claim 3] A method for laminating optical disk according to Claim 1 or 2, wherein

said first ultraviolet irradiation process is characterized by irradiating an exposure dose of ultraviolet rays in pulses at an illuminance that does not completely cure said ultraviolet-curing

* Claim and paragraph numbers correspond to those in the foreign text.

adhesive.

[Claim 4] A method for laminating optical disk in any of Claims 1 to 3, wherein

said first ultraviolet irradiation process is characterized by irradiating ultraviolet rays on said two layered single plate disks from a point light source at an illuminance and exposure dose that does not completely cure said ultraviolet-curing adhesive, and irradiating at a degree of spacing that these ultraviolet rays strike nearly the entire surface.

[Claim 5] A method for laminating optical disk in any of Claims 1 to 4, wherein

said first ultraviolet irradiation process is characterized by using ultraviolet rays of lower illuminance than said second ultraviolet irradiation process.

[Claim 6] A method for laminating optical disk in any of Claims 1 to 5, wherein

said first ultraviolet irradiation process is characterized by using a lower exposure dose than said second ultraviolet irradiation process.

[Claim 7] A method for laminating optical disk in any of Claims 1 to 6, wherein

said second ultraviolet irradiation process is characterized by irradiating ultraviolet rays from both above and below said two layered single plate disks.

[Claim 8] A method for laminating optical disk in any of Claims 1 to 7, wherein

said second ultraviolet irradiation process is characterized by irradiating an exposure dose of ultraviolet rays in pulses at an illuminance that does not completely cure said ultraviolet-curing adhesive.

[Claim 9] A method for laminating optical disk in any of Claims 1 to 8, wherein

characterized by keeping the uncured layered disks adhered to a flat surface for a predetermined time after said first ultraviolet irradiation process before carrying out said second ultraviolet irradiation process.

[Claim 10] A method for laminating optical disk using a liquid ultraviolet-curing adhesive to laminate two single plate disks to form a single laminated disk, characterized by

providing a first process for obtaining a laminated disk by irradiating ultraviolet rays at an exposure dose curing said ultraviolet-curing adhesive in a condition not applying mechanical stress to the center holes of the two single plate disks layered with the liquid ultraviolet-curing adhesive in between, and

aligning said center holes with a removal position after this first process before removing said laminated disk.

[Claim 11] A device for laminating optical disk using a liquid ultraviolet-curing adhesive to laminate two single plate disks to

form a single laminated disk, characterized by providing

an expanding/contracting mechanism having at least three movable members configured capable of entering the center holes of the two single plate disks layered with said liquid ultraviolet-curing adhesive in between, and capable of expanding or contracting the diameter radially within said center holes, and

a first ultraviolet irradiation device for irradiating an exposure dose of ultraviolet rays that does not completely cure said ultraviolet-curing adhesive when said expanding/contracting mechanism has expanded the diameter,

a support member for supporting the bottom of said uncured layered disks without applying mechanical stress to said center holes of said uncured layered disks, and

a second ultraviolet irradiation device for irradiating an exposure dose of ultraviolet rays on said uncured layered disks supported by this support member for completely curing said ultraviolet-curing adhesive, thereby obtaining a laminated disk with little warping.

[Claim 12] A device for laminating optical disk in Claim 11, wherein

said support member is characterized by providing a pin-shaped member capable of entering the center holes of said uncured layered disks leaving a sufficient gap to avoid contact, and irradiating ultraviolet rays in a state avoiding horizontal misalignment of said

uncured layered disks to obtain a laminated disk with little warping.

[Claim 13] A device for laminating optical disk in Claim 11 or 12, wherein

said flat surface of said support member is made of glass, and said second ultraviolet irradiation device is set up below said support member to irradiate ultraviolet rays for completely curing said liquid ultraviolet-curing adhesive from below said uncured layered disks.

[Claim 14] A device for laminating optical disk in any of Claims 11 to 13, wherein

said flat surface of said support member is made of glass, and said second ultraviolet irradiation device is set up above and below said support member to irradiate ultraviolet rays for completely curing said ultraviolet-curing adhesive both from above and below said uncured layered disks.

[Claim 15] A device for laminating optical disk in any of Claims 11 to 14, wherein

either or both of said first and second ultraviolet irradiation devices is characterized by irradiating ultraviolet rays in pulses.

[Claim 16] A device for laminating optical disk in any of Claims 11 to 15, wherein

said support member is characterized by having a pin-shaped member in the center having a smaller radius than the radius of said center holes of said uncured layered disks.

[Claim 17] A device for laminating optical disk in any of Claims 11 to 16, wherein

said first ultraviolet irradiation device is characterized by irradiating an exposure dose of ultraviolet rays of a degree to make said ultraviolet-curing adhesive a liquid to gel with increased viscosity.

[Claim 18] A device for laminating optical disk in any of Claims 11 to 17, wherein

said first ultraviolet irradiation device is characterized by irradiating ultraviolet rays in pulses.

[Claim 19] A device for laminating optical disk in any of Claims 11 to 18, wherein

said first ultraviolet irradiation device is characterized by having an irradiator for emitting pointed light.

[Claim 20] A device for laminating optical disk using a liquid ultraviolet-curing adhesive to laminate two single plate disks to form a single laminated disk, characterized by providing

a support member for supporting said two single plate disks without applying mechanical stress to the center holes of said two single plate disks when said ultraviolet-curing adhesive between said two single plate disks is not cured,

an ultraviolet irradiation device for irradiating ultraviolet rays to cure said ultraviolet-curing adhesive between said two single plate disks,

a positioning member for entering said center holes to align with a removal position before removing the laminated disk comprised by curing said ultraviolet-curing adhesive, and

a removing device for removing said laminated disk.

[Claim 21] A device for laminating optical disk in Claim 20, wherein

said support member is characterized by not having a member for entering the center holes of said two single plate disks when said ultraviolet-curing adhesive between said two single plate disks is not cured.

[Claim 22] A device for laminating optical disk in any of Claims 11 to 21, wherein

said support member is characterized by having a flat surface for adhering and holding said uncured layered disks.

[Claim 23] A device for laminating optical disk in any of Claims 11 to 22, wherein

said support member is characterized by having a circular hole of larger diameter than the diameter of said center holes, and having a member entering or withdrawing from said center holes through said circular hole from above said positioning member.

[DETAILED EXPLANATION OF THE INVENTION]

[0001] [INDUSTRIAL FIELD OF APPLICATION]

The present invention relates to a method and device for laminating an optical disk, by which two disks are laminated to form

a single optical disk in a method and device for manufacturing an optical disk.

[0002] [PRIOR ART]

Fig. 7 shows an example of a conventional method and device for laminating an optical disk, especially a method and device for laminating an optical disk using a liquid ultraviolet-curing adhesive.

[0003] The configuration of a conventional example will be discussed following Fig. 7. First, a processing apparatus (not shown) sets layered disks 4 before curing comprising two layered single plate disks 1 and 2 with an evenly spread liquid ultraviolet-curing adhesive 3 in between on top of a support member 30. The support member 30 has a pin-shaped member 31 in the center to engage the center holes of the uncured layered disks 4. The pin-shaped member 31 comprises a member 32 capable of elastically moving radially around the center, and in its natural state has a larger diameter than the center holes of the two layered single plate disks 1 and 2. Ultraviolet irradiation devices 33 and 34 are provided above and below in the forward direction of the support member 30.

[0004] Next, the operation of the conventional example of Fig. 7 will be discussed. When a feed apparatus (not shown) sets uncured layered disks 4 that have not been cured by ultraviolet rays on top of the support member 30, the pin-shaped member 31 engages the center holes of the uncured layered disks 4. Upon doing so, the elastically

movable member 32 moves elastically to become the same diameter as the center holes of the single plate disks 1 and 2. The reaction to this action brings a force to bear that maximizes the center holes of the uncured layered disks 4 to align the two single plate disks 1 and 2 comprising the uncured layered disks 4. The support member 30 is moved horizontally in this state to bring to a position between the ultraviolet irradiation devices 33 and 34, which irradiate ultraviolet rays to cure the ultraviolet-curing adhesive 3. Thus, the two single plate disks 1 and 2 can be laminated.

[0005] [PROBLEMS THAT THE INVENTION IS TO SOLVE]

Such a conventional method and device, however, have the problem of applying great stress to the center holes of the uncured layered disks 4 when irradiating ultraviolet rays to cure the ultraviolet-curing adhesive 3.

[0006] Optical disks are often formed by injection molding a plastic material, but when the center hole of a disk reaches the molten resin charge port area in a molding die and is removed from the molder, a punch cuts out the spool of unnecessary resin collected in the center hole to form the center hole of the disk. Hence, the area near the center hole of a disk is easily deformed and has greater residual stress after cooling the disk than other parts. As a result, the center hole area of a disk is usually formed in a steep warped state. Applying stress to this area causes great deformation in the outer edge of the disk.

[0007] By forming the two single plate disks 1 and 2 comprising the uncured layered disks 4 in this way, curing the adhesive 3 by a method such as shown in Fig. 7 fixes the shape of the laminated disk in a greatly deformed state, producing a cured laminated disk with great warpage.

[0008] This tendency is greater for recording disks having a recording layer on a single plate disk; for example, among DVD (digital personal disks), DVD-RAM or DVD-RW. The reason for this is, first, a recording layer comprises a multilayer film, and forming this film greatly warps the single plate disk. Second, a formed recording layer is harder than just a reflecting layer, which increases the bending rigidity of the formed single plate disk and makes it difficult to correct disk warpage caused by laminating. Specifically, if the warpage of two single plate disks is even a little unbalanced, bending force is stronger on the disk with greater warpage and tends to leave greater warpage after laminating. Since a single plate disk inherently has great warpage and the unbalance in the warpage of two single plate disks tends to warp the laminated disk as just discussed, a conventional method such as shown in Fig. 7 tends to cause great warpage when laminating a recording disk.

[0009] Therefore, the present invention layers two single plate disks with an ultraviolet-curing adhesive in between, carries out a first ultraviolet irradiation with the center holes of these disks mechanically aligned to thicken the ultraviolet-curing adhesive to a

degree that does not warp the two single plate disks and keep the center holes from slipping out of alignment, then carries out a second ultraviolet irradiation in a condition not applying mechanical stress to the center holes to address the problem of obtaining a laminated disk with little warpage. Holding the two single plate disks with an ultraviolet-curing adhesive in between tightly against the flat surface of a support member to minimize warpage when carrying out the second ultraviolet irradiation also addresses the problem of obtaining a laminated disk with little warpage.

[0010] [MEANS OF SOLVING THE PROBLEMS]

To solve this problem, the invention of Claim 1 provides a method for laminating optical disk using a liquid ultraviolet-curing adhesive to laminate two single plate disks to form a single laminated disk, characterized by providing a first ultraviolet irradiation process for obtaining uncured layered disks by irradiating ultraviolet rays to a degree not completely curing the ultraviolet-curing adhesive while mechanically aligning the center holes of the two single plate disks layered with the liquid ultraviolet-curing adhesive in between, and a second ultraviolet irradiation process for irradiating the layered two single plate disks with ultraviolet rays to a degree completely curing the ultraviolet-curing adhesive to obtain a laminated disk.

[0011] To solve this problem, the invention of Claim 2 provides a method for laminating optical disk wherein in Claim 1, the first

ultraviolet irradiation process is characterized by making the ultraviolet-curing adhesive between the two layered single plate disks a liquid to gel with increased viscosity.

[0012] To solve this problem, the invention of Claim 3 provides a method for laminating optical disk wherein in Claim 1 or 2, the first ultraviolet irradiation process is characterized by irradiating an exposure dose of ultraviolet rays in pulses at an illuminance that does not completely cure the ultraviolet-curing adhesive.

[0013] To solve this problem, the invention of Claim 4 provides a method for laminating optical disk wherein in any of Claims 1 to 3, the first ultraviolet irradiation process is characterized by irradiating ultraviolet rays on the two layered single plate disks from a point light source at an illuminance and exposure dose that does not completely cure the ultraviolet-curing adhesive, and irradiating at a degree of spacing that these ultraviolet rays strike nearly the entire surface.

[0014] To solve this problem, the invention of Claim 5 provides a method for laminating optical disk wherein in any of Claims 1 to 4, the first ultraviolet irradiation process is characterized by using ultraviolet rays of lower illuminance than the second ultraviolet irradiation process.

[0015] To solve this problem, the invention of Claim 6 provides a method for laminating optical disk wherein in any of Claims 1 to 5, the first ultraviolet irradiation process is characterized by using a

lower exposure dose than the second ultraviolet irradiation process.

[0016] To solve this problem, the invention of Claim 7 provides a method for laminating optical disk wherein in any of Claims 1 to 6, the second ultraviolet irradiation process is characterized by irradiating ultraviolet rays from both above and below the two layered single plate disks.

[0017] To solve this problem, the invention of Claim 8 provides a method for laminating optical disk wherein in any of Claims 1 to 7, the second ultraviolet irradiation process is characterized by irradiating an exposure dose of ultraviolet rays in pulses at an illuminance that does not completely cure the ultraviolet-curing adhesive.

[0018] To solve this problem, the invention of Claim 9 provides a method for laminating optical disk wherein in any of Claims 1 to 8, characterized by keeping the uncured layered disks adhered to a flat surface for a predetermined time after the first ultraviolet irradiation process before carrying out the second ultraviolet irradiation process.

[0019] To solve this problem, the invention of Claim 10 provides a method for laminating optical disk using a liquid ultraviolet-curing adhesive to laminate two single plate disks to form a single laminated disk, characterized by providing a first process for obtaining a laminated disk by irradiating ultraviolet rays at an exposure dose curing the ultraviolet-curing adhesive in a condition

not applying mechanical stress to the center holes of the two single plate disks layered with the liquid ultraviolet-curing adhesive in between, and aligning the center holes with a removal position after this first process before removing the laminated disk.

[0020] To solve this problem, the invention of Claim 11 provides a device for laminating optical disk using a liquid ultraviolet-curing adhesive to laminate two single plate disks to form a single laminated disk, characterized by providing an expanding/contracting mechanism having at least three movable members configured capable of entering the center holes of the two single plate disks layered with the liquid ultraviolet-curing adhesive in between, and capable of expanding or contracting the diameter radially within the center holes, and a first ultraviolet irradiation device for irradiating an exposure dose of ultraviolet rays that does not completely cure the ultraviolet-curing adhesive when the expanding/contracting mechanism has expanded the diameter, a support member for supporting the bottom of the uncured layered disks without applying mechanical stress to the center holes of the uncured layered disks, and a second ultraviolet irradiation device for irradiating an exposure dose of ultraviolet rays on the uncured layered disks supported by this support member for completely curing the ultraviolet-curing adhesive, thereby obtaining a laminated disk with little warping.

[0021] To solve this problem, the invention of Claim 12 provides a device for laminating optical disk wherein in Claim 11, the support

member is characterized by providing a pin-shaped member capable of entering the center holes of the uncured layered disks leaving a sufficient gap to avoid contact, and irradiating ultraviolet rays in a state avoiding horizontal misalignment of the uncured layered disks to obtain a laminated disk with little warping.

[0022] To solve this problem, the invention of Claim 13 provides a device for laminating optical disk wherein in Claim 11 or 12, the flat surface of the support member is made of glass, and the second ultraviolet irradiation device is set up below the support member to irradiate ultraviolet rays for completely curing the ultraviolet-curing adhesive from below the uncured layered disks.

[0023] To solve this problem, the invention of Claim 14 provides a device for laminating optical disk wherein in any of Claims 11 to 13, the flat surface of the support member is made of glass, and the second ultraviolet irradiation device is set up above and below the support member to irradiate ultraviolet rays for completely curing the ultraviolet-curing adhesive both from above and below the uncured layered disks.

[0024] To solve this problem, the invention of Claim 15 provides a device for laminating optical disk wherein in any of Claims 11 to 14, either or both of the first and second ultraviolet irradiation devices is characterized by irradiating ultraviolet rays in pulses.

[0025] To solve this problem, the invention of Claim 16 provides a device for laminating optical disk wherein in any of Claims 11 to

15, the support member is characterized by having a pin-shaped member in the center having a smaller radius than the radius of the center holes of the uncured layered disks.

[0026] To solve this problem, the invention of Claim 17 provides a device for laminating optical disk wherein in any of Claims 11 to 16, the first ultraviolet irradiation device is characterized by irradiating an exposure dose of ultraviolet rays of a degree to make the ultraviolet-curing adhesive a liquid to gel with increased viscosity.

[0027] To solve this problem, the invention of Claim 18 provides a device for laminating optical disk wherein in any of Claims 11 to 17, the first ultraviolet irradiation device is characterized by irradiating ultraviolet rays in pulses.

[0028] To solve this problem, the invention of Claim 19 provides a device for laminating optical disk wherein in any of Claims 11 to 18, the first ultraviolet irradiation device is characterized by having an irradiator for emitting pointed light.

[0029] To solve this problem, the invention of Claim 20 provides a device for laminating optical disk using a liquid ultraviolet-curing adhesive to laminate two single plate disks to form a single laminated disk, characterized by providing a support member for supporting the two single plate disks without applying mechanical stress to the center holes of the two single plate disks when the ultraviolet-curing adhesive between the two single plate disks is not

cured, an ultraviolet irradiation device for irradiating ultraviolet rays to cure the ultraviolet-curing adhesive between the two single plate disks, a positioning member for entering the center holes to align with a removal position before removing the laminated disk comprised by curing the ultraviolet-curing adhesive, and a removing device for removing the laminated disk.

[0030] To solve this problem, the invention of Claim 21 provides a device for laminating optical disk wherein in Claim 20, the support member is characterized by not having a member for entering the center holes of the two single plate disks when the ultraviolet-curing adhesive between the two single plate disks is not cured.

[0031] To solve this problem, the invention of Claim 22 provides a device for laminating optical disk wherein in any of Claims 11 to 21, the support member is characterized by having a flat surface for adhering and holding the uncured layered disks.

[0032] To solve this problem, the invention of Claim 23 provides a device for laminating optical disk wherein in any of Claims 11 to 22, the support member is characterized by having a circular hole of larger diameter than the diameter of the center holes, and having a member entering or withdrawing from the center holes through the circular hole from above the positioning member.

[0033] EMBODIMENT AND WORKING EXAMPLES OF THE INVENTION

A working example according to the present invention will be discussed using Fig. 1. First, the configuration will be discussed. A

positioning stage 5, on which are set uncured layered disks 4 not yet irradiated with ultraviolet rays and having a liquid ultraviolet-curing adhesive 3 evenly spread between two single plate disks 1 and 2, is arranged in a processing apparatus (not shown), and a first ultraviolet irradiation device 6 is installed above this.

[0034] To weaken the intensity of ultraviolet rays received by the uncured layered disks 4 from this first ultraviolet irradiation device 6, the gap between the first ultraviolet irradiation device 6 and the positioning stage 5 is made about three to five times the regular irradiation distance of the first ultraviolet irradiation device 6. To give an example, in the case of an irradiator fitted with a collector type metal halide lamp with an emission wavelength of 250 mm often used, for example, to cure the adhesive in a DVD, the regular irradiation distance is often about 80 mm to 100 mm from the center of the lamp, but in this case, the irradiation distance is made about 240 mm to 500 mm from the center of the lamp. The first ultraviolet irradiation device 6 houses a shutter mechanism. A lift type shielding tube 7 between the first ultraviolet irradiation device 6 and the positioning stage 5 is also provided to prevent leakage of ultraviolet rays during ultraviolet irradiation. Although the first ultraviolet irradiation device 6 in this example is a continuous emission type such as a metal halide lamp, a pulse emission type such as a xenon flash lamp may be used. Naturally, the irradiation distance discussed earlier is shorter when using a lamp

with low illuminance.

[0035] The center projection of the positioning stage 5 is provided with a positioning pin 8 comprising three pin-shaped members for entering the center holes of the uncured layered disks 4 to expand the diameter of the uncured layered disks 4 radially from the center, and is driven by an air cylinder 9, the output section of which acts radially. The outer diameter of the positioning pin 8 is set at less than the diameter of the center holes of the single plate disks 1 and 2 when contracted, and greater than the diameter of the center holes of the single plate disks 1 and 2 when fully expanded.

[0036] A feeding arm 10 and a turntable 11 are arranged near the positioning stage 5. The feeding arm 10 is a unit for vacuum-adsorbing the uncured layered disks 4 subjected to ultraviolet irradiation onto the positioning stage 5 to feed above the turntable 11.

[0037] The turntable 11 is a turntable having three support members 12 for supporting the flat surface of the uncured layered disks 4 arranged at equal divisions of 120°, and feeds the uncured layered disks 4 from a supply position P1 through an ultraviolet irradiation position P2 to a removal position P3. The turntable 11 may also have two support members 12 arranged at equal divisions of 180°, or four support members 12 arranged at equal divisions of 90°. If two support members 12 are arranged, the disk supply position and the disk removal position are the same. If four support members 12

are arranged, a position for cooling the support member 12 applying heat during ultraviolet irradiation is often disposed between the disk removal position and the disk supply position.

[0038] Next, the configuration of the support member 12 will be discussed using Fig. 2. Fig. 2 is a section view of the support member 12 including a portion of the turntable 11. The support member 12 is made of transparent glass, for which quartz glass or heat-resistant glass is often used because of the need for a high ultraviolet transmission factor and the need to withstand the heat applied during ultraviolet irradiation. The support member 12 is made round, and has formed on its top surface a flat surface 13 for tightly holding the flat surface of the uncured layered disks 4, and a clearance groove 15 for preventing interference with a circular projection for blocking lamination 14 during accumulation to form the uncured layered disks 4. A center hole 16 larger than the center holes of the single plate disks 1 and 2 is formed in the center portion of the support member 12. A round depression in the turntable 11 also lies below the support member 12 in this center portion, and ultraviolet rays irradiated from below pass through the transparent support member 12 to strike the uncured layered disks 4. Some disks are not formed with the circular projection for blocking lamination 14, in which case, the clearance groove 15 is not needed. In the working examples discussed later, cases without the clearance groove 15 will be indicated to simplify the discussion.

[0039] The discussion will now return to Fig. 1. Second and third ultraviolet irradiation devices 17 and 18 are arranged above and below the support member 12 in the ultraviolet irradiation position P2 of the turntable 11. These second and third ultraviolet irradiation devices 17 and 18 are arranged in locations at the regular irradiation distance from the support member 12, and irradiate ultraviolet rays of an intensity that cannot completely cure the ultraviolet-curing adhesive 3 between the uncured layered disks 4 on the support member 12. Although these second and third ultraviolet irradiation devices 17 and 18 are a continuous emission type such as metal halide lamps, a pulse emission type such as xenon flash lamps may be used. If the uncured layered disks 4 have a high ultraviolet transmission factor, just one of the second ultraviolet irradiation device 17 arranged above the support member 12 or the third ultraviolet irradiation device 18 arranged below the support member 12 may be arranged.

[0040] Next, the operation of the working example in Fig. 1 will be discussed. When uncured layered disks 4 having a liquid ultraviolet-curing adhesive 3 spread evenly between two single plate disks 1 and 2 and set on the positioning stage 5 by a feed apparatus (not shown) is arranged in a processing apparatus (not shown), a drive source (not shown) lowers the shielding tube 7 to close the open area and prevent leakage of ultraviolet rays, and the air cylinder 9 is activated to radially expand the diameter of the

positioning pin 8, which starts at the minimum diameter, to align with the position of the center holes of the single plate disks 1 and 2 comprising the uncured layered disks 4. Next, the first ultraviolet irradiation device 6 irradiates ultraviolet rays of an intensity that does not completely cure the ultraviolet-curing adhesive 3. In this state, the ultraviolet-curing adhesive 3, though not enough to call sufficiently cured, has fairly high viscosity, which makes the two single plate disks 1 and 2 unlikely to fall out of alignment. Therefore, the two single plate disks 1 and 2 do not become misaligned during subsequent processing. The intensity of these ultraviolet rays corresponds to the illuminance of the ultraviolet rays on the upper surface of the two single plate disks 1 and 2, or an exposure dose found from the product of illuminance and time.

[0041] Next, the positioning pin 8 radially contracts in diameter to return to the minimum diameter and the shielding tube 7 is raised, then the feeding arm 10 sets the uncured layered disks 4 on the support member 12 in the supply position P1 of the turntable 11. The turntable 11 is then rotated 120° to feed the uncured layered disks 4 to the ultraviolet irradiation position P2.

[0042] In the ultraviolet irradiation position P2, the second and third ultraviolet irradiation devices 17 and 18 irradiate ultraviolet rays of an intensity completely curing the ultraviolet-curing adhesive 3 from above and below the uncured layered disks 4, which completely cures the adhesive 3 to make the uncured layered

disks 4 a laminated disk 19. The turntable 11 is then rotated 120° to feed the cured laminated disk 19 to the removal position P3. In this position, the feed apparatus (not shown) removes the laminated disk 19.

[0043] Next, the operation of the working example shown in Fig. 1 will be discussed. Satisfying the requirements of the present invention, namely, no misalignment between the two single plate disks to be laminated and curing the ultraviolet-curing adhesive without contacting the center hole of the single plate disks to be laminated, obtains a laminated disk with little warpage. Important conditions for this are that the ultraviolet rays received on the positioning stage 5 in Fig. 1 bring the film of the ultraviolet-curing adhesive 3 in between the uncured layered disks 4 to a highly viscous liquid or gelled — that is, sufficiently soft — state while producing substantially no change in the condition of the uncured layered disks 4 not yet cured by ultraviolet rays, and keeping the two single plate disks 1 and 2 aligned through the end of processing. The ultraviolet-curing adhesive 3 is completely cured while satisfying these conditions.

[0044] The state of warpage of the cured laminated disk 19 is ultimately determined by the state of warpage of the uncured layered disks 4 when the ultraviolet-curing adhesive 3 is completely cured. Therefore, the method for supporting the uncured layered disks 4 is important. The present invention holds the uncured layered disks 4 in

a flat condition with no warpage to allow irradiation of ultraviolet rays to completely cure the ultraviolet-curing adhesive 3 by employing support members 12 that support just the flat surface of the uncured layered disks 4 without the members contacting the center holes of the uncured layered disks 4; that is, without applying mechanical stress. This operation is shown in Fig. 3.

[0045] Fig. 3 is a diagram showing the state when the uncured layered disks 4 are set on the support member 12 at the supply position P1 of the turntable 11. Because the single plate disks 1 and 2 cannot be obtained in completely the same state of warpage, the uncured layered disks 4 are warped with the center bulging either upward or downward. The characteristics of injection molding discussed earlier also usually cause the single plate disks 1 and 2 to warp sharply near their center holes. Therefore, the uncured layered disks 4 are often warped sharply near the center and more gently at the outer edge. If the uncured layered disks 4 are warped with the center bulging downward, its own weight brings an upward vertical drag to bear on this bulge, bending the outer edge downward. As a result, the center is bent bulging upward. Ultimately, the uncured layered disks bulges upward on the support member 12. Fig. 3 shows such a state.

[0046] In Fig. 3, Fig. 3(a) shows the state just after setting the uncured layered disks 4 on the support member 12, and Fig. 3(b) shows the state after some time has passed. The change from Fig. 3(a)

to Fig. 3(b) occurs in fact in a short time of about one second. In Fig. 3(a), of the uncured layered disks 4, the relatively gently warped outer edge adheres first to the flat surface 13 of the support member 12 and flattens. This is because the uncured layered disks 4 deforms relatively readily due to the softness of the film of the ultraviolet-curing adhesive 3. That is, a single plate disk of an optical disk being thin and flexible, its own weight adheres the uncured layered disks 4 readily to the flat surface 13. Because there is no member engaging the center holes of the uncured layered disks during this process, no action occurs that could block the uncured layered disks 4 adhering to the flat surface 13. Due to these actions, the uncured layered disks 4 starts adhering to the flat surface 13 from its outer edge, the adhering area spreads to its inner edge until nearly the entire surface of the uncured layered disks 4 adheres to the flat surface 13 at the stage in Fig. 3(b); that is, the entire surface of the uncured layered disks 4 is held flat. Irradiating ultraviolet rays to completely cure the ultraviolet-curing adhesive 3 while held in this state shown in Fig. 3(b) obtains a fully cured laminated disk with little warpage.

[0047] Fig. 4 is a diagram showing a second working example, and shows an effective example when the feed time of the uncured layered disks 4 is short. The working example shown in Fig. 4 has a pin-shaped member 20 arranged in the center of the support member 12. The tip 21 of the pin-shaped member 20 is shaped so as to enter the

center holes of the uncured layered disks 4, and the diameter of the tip 21 is formed about 1 mm to 2 mm smaller than the diameter of the center holes of the single plate disks 1 and 2.

[0048] This configuration assures that the tip 21 does not contact the center holes when the uncured layered disks 4 is set on the support member 12 at the supply position P1 of the turntable 11 in Fig. 1. Next, after nearly the entire surface of the uncured layered disks 4 adheres to the flat surface 13 of the support member 12 as shown in Fig. 3, the turntable 11 is rotated to feed the uncured layered disks 4 to the ultraviolet irradiation position P2, but setting this feed time to a short time increases the rotational acceleration of the turntable 11, which tends to misalign the uncured layered disks 4 horizontally. The vertical edge of the center holes of the uncured layered disks 4, however, strikes the tip 21 to prevent misalignment in this case as well, and keeps the alignment within a range that allows feeding by a feeding apparatus later. Since nearly the entire surface of the uncured layered disks 4 is already adhered to the flat surface 13 of the support member 12, the warpage of the laminated disk does not increase after completely curing the ultraviolet-curing adhesive 3.

[0049] Fig. 5 is a diagram showing a third working example. The working example shown in Fig. 5 has a configuration in which the first ultraviolet irradiation device in Fig. 1 has an irradiator emitting pointed light 22, and an optical fiber 23 guides the

ultraviolet rays from an light source device (not shown). The irradiation distance must be sufficiently long during this process because the irradiated ultraviolet rays strike the entire surface of the uncured layered disks 4. To give an example, in the case of a DVD with a diameter of 120 mm, the irradiation distance is often set at about 150 mm to 300 mm. The working example shown in Fig. 5 has the advantage that the configuration around this ultraviolet irradiation device can be made smaller.

[0050] Fig. 6 is a diagram showing a fourth working example. The working example shown in Fig. 6 has a pin-shaped member 24 and a lift type air cylinder 25 for this member arranged below the removal position P3 of the turntable 11 in Fig. 1. The pin-shaped member 24 has a tapered tip and a cylindrical base. The diameter of the cylindrical base is greater than the diameter of the center hole of the cured laminated disk 19, but smaller than the diameter of the center hole of the support member 12. The center line of the pin-shaped member 24 is aligned with the center line of a suction hand of the feeding apparatus (not shown). When the cured laminated disk 19 arrives at the removal position P3, the pin-shaped member 24 is positioned below the support member 12 as shown in Fig. 6(a), but the air cylinder 25 is activated to raise the pin-shaped member 24 as shown in Fig. 6(b). The pin-shaped member 24 is raised through the center hole 16 of the support member 12, and the tapered tip catches and lifts the center hole of the cured laminated disk 19 midway. When

the pin-shaped member 24 reaches the upper limit position, the action of the tapered tip aligns the center line of the cured laminated disk 19 with the center line of the pin-shaped member 24. That is, the center line of the cured laminated disk 19 is aligned with the center line of the suction hand of the feeding apparatus (not shown). This action can prevent any obstruction to feeding later even if the cured laminated disk 19 is misaligned horizontally during the process of feeding by the turntable 11.

[0051] The working examples discussed above can be employed for either a DVD-5 (a single-layer, single-sided disk) or a DVD-9 (a two-layer, single-sided disk) in which just either one of two single plate disks is formed with one or two reflective layers, or a DVD-10 (a single-layer, double-sided disk) or a DVD-18 (a double-layer, double-sided disk) in which both of two single plate disks have one or two reflective layers, and are especially effective for a DVD-9 (a double-layer, single-sided disk) or a DVD-18 (a double-layer, double-sided disk), which includes a process for peeling the single plate disk without a reflective layer, as such a DVD has relatively great warpage near the center hole as discussed earlier. These working examples are also effective for a DVD-RAM or DVD-RW in which either one of two single plate disks has a recording layer, and are also effective when both of two single plate disks have recording layers if the recording layers have a high ultraviolet transmission factor.

[0052] [EFFECTS OF THE INVENTION]

As discussed above, the present invention can obtain a laminated disk with no misalignment and little warpage by completing a process for aligning two single plate disks to be laminated while an adhesive between the two disks is in a insufficiently cured soft state, before carrying out a process for completely curing the adhesive in a condition applying hardly any mechanical stress to the center holes of the laminated disk.

[BRIEF EXPLANATION OF THE DRAWINGS]

FIG. 1 is a diagram showing the overall configuration of a first working example according to the present invention.

FIG. 2 is a diagram showing part of the configuration of a first working example according to the present invention.

FIG. 3 is a diagram illustrating the operation of a first working example according to the present invention.

FIG. 4 is a diagram showing a second working example according to the present invention.

FIG. 5 is a diagram showing a third working example according to the present invention.

FIG. 6 is a diagram showing a fourth working example according to the present invention.

FIG. 7 is a diagram showing an example of a conventional disk laminating apparatus.

[EXPLANATION OF REFERENCE NUMBERS]

1 - Single plate disk

2 - Single plate disk

3 - Liquid ultraviolet-curing adhesive

4 - Uncured layered disks

5 - Positioning stage

6 - First ultraviolet irradiation device

7 - Shielding tube

8 - Positioning pin

9 - Air cylinder

10 - Feeding arm

11 - Turntable

12 - Support member

13 - Flat surface

14 - Circular projection for blocking lamination

15 - Clearance groove

16 - Center hole

17 - Second ultraviolet irradiation device

18 - Third ultraviolet irradiation device

19 - Cured laminated disk

20 - Pin-shaped member

21 - Tip

22 - Irradiator emitting pointed light

23 - Optical fiber

24 - Pin-shaped member

25 - Air cylinder

30 - Support member

31 - Pin-shaped member

32 - Elastically movable member

33 - Ultraviolet irradiation device

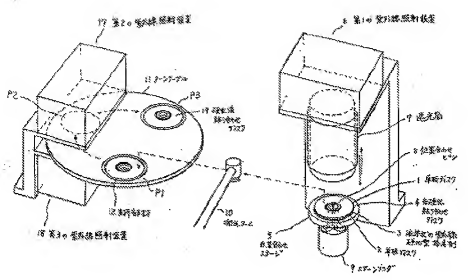
34 - Ultraviolet irradiation device

P1 - Disk supply position of turntable 11

P2 - Ultraviolet irradiation position of turntable 11

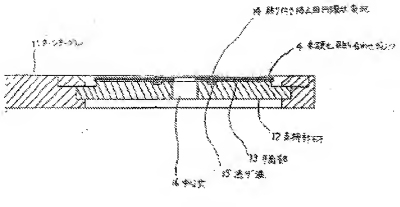
P3 - Disk removal position of turntable 11

FIG. 1



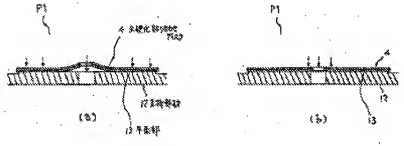
17- Second ultraviolet irradiation device
11- Turntable
19- Cured laminated disk
10- Feeding arm
12- Support member
18- Third ultraviolet irradiation device
6- First ultraviolet irradiation device
7- Shielding tube
8- Positioning pin
1- Single plate disk
4- Uncured layered disk
3- Liquid UV-curing adhesive
2- Single plate disk
9- Air cylinder
5- Positioning stage

FIG. 2



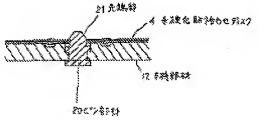
11- Turntable
14- Circular projection for blocking lamination
4- Uncured layered disk
12- Support member
13- Flat surface
15- Clearance groove
16- Center hole

FIG. 3



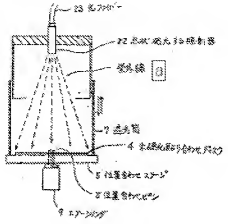
4- Uncred layered disk
12- Support member
13- Flat surface

FIG. 4



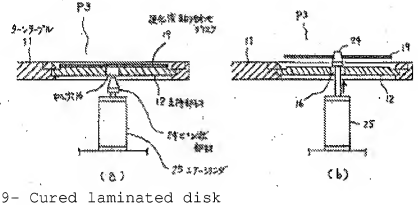
21- Tip
4- Uncured layered disk
12- Support member
20- Pin-shaped member

FIG. 5



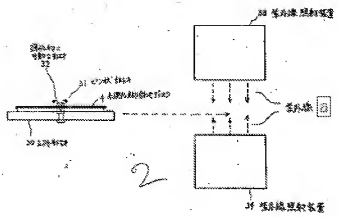
23- Optical fiber
22- Irradiator emitting pointed light
a) Ultraviolet rays
7- Shielding tube
4- Uncured layered disk
5- Positioning stage
8- Positioning pin
9- Air cylinder

FIG. 6



19- Cured laminated disk
16- Center hole
12- Support member
24- Pin-shaped member
25- Air cylinder

FIG. 7



32- Elastically movable member
31- Pin-shaped member
4- Uncured layered disk
30- Support member
33- Ultraviolet irradiation device
a) Ultraviolet rays
34- Ultraviolet irradiation device